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Final Report for Subcontract# B539681

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Final Report for Subcontract# B539681

Massachusetts Institute of Technology (MIT)
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This report summarizes the work performed under subcontract# B539681. The scope of work described in the subcontract encompasses studies of fundamental research for fast ignition. The work statement from the original subcontract and the subsequent extension can be summarized in three major components: modeling of electron transport in experimental targets, development of diagnostics, and experimental implementation and analysis.

All three of these areas have been addressed during the subcontract period, although the tasks detailed in the original subcontract were adapted to research conditions with guidance from the technical contact. The work performed in each of these areas is described below.

Modeling of electron transport in experimental targets

Electron transport and x-ray generation in experimental targets were modeled with the Monte Carlo code Integrated Tiger Series 3.0 (ITS 3.0). This code package was also used to model the response of Bremsstrahlung spectrometer described in the following section. The modeling helped with target and spectrometer designs and was also used to interpret the measured data from the experiments. This work is coupled to the diagnostic development and experimental analysis and is described in the deliverables of the following sections.

Diagnostic Development

During the subcontract period a filter-stack Bremsstrahlung spectrometer using image plate dosimeters was developed, tested, and calibrated. The spectrometer design and sample data taken with the spectrometer was presented at the High Temperature Plasma Diagnostics conference (Albuquerque, NM 2008). The information was also subsequently published in the peer-reviewed conference proceedings (Rev. Sci. Instrum. **79**:10E305 (2008)). The diagnostic was fielded on over 10 experiments at the Jupiter Laser Facility at Lawrence Livermore and was also adapted for use on OMEGA EP, as discussed in the subcontract extension. A composition study of the image plate dosimeters was also disseminated as an internal LLNL technical memo.

In addition, research was performed into two other diagnostics. Single Photon Counting using a CCD (Single Hit Spectrometer) is a well-established technique in the literature. The subcontractor assisted with implementation and calibration of the Single Hit Spectrometer and developed general use software for analysis of the output data. This software is currently being used by a number of collaborators at Lawrence Livermore. The development of a Single Hit Imager was also initially explored at the beginning of the subcontract period but, under direction of the technical contact, not further pursued in order to focus on other priorities.

Experimental Implementation and Analysis

The subcontractor participated in over 10 separate 2-8 week experiments at the Jupiter Laser Facility at Lawrence Livermore. On many of these experiments, the diagnostics described above were fielded to take x-ray measurements for different physics goals, including those described in the original subcontract and for studies of diagnostic related issues for the National Ignition Facility. A series of experiments were carried out on planar foil targets to study the electrons generated in the relativistic laser plasma interaction under fast ignition relevant conditions. The data was analyzed with the Monte Carlo modeling described above. This work was presented as talks and posters at three national conferences and has been submitted for publication in Physics of Plasmas. Conclusions from this work were useful in advancing the current state of fast ignition research.

In summary, the following tasks were accomplished under the subcontract:

1. Monte Carlo modeling of electron transport in experimental targets
2. Design, implementation, and calibration of a filter-stack Bremsstrahlung spectrometer
3. Monte Carlo modeling of the spectrometer response
4. Adaptation of the spectrometer design for use on OMEGA EP
5. Implementation and Calibration of a Single Hit Spectrometer
6. Development of general use software for Single Hit Spectrometer data analysis
7. Preliminary study of a Single Hit Imager
8. Participation in over 10 experiments at the Jupiter Laser Facility at Lawrence Livermore
9. Experimental study of electron generation from relativistic laser plasma interactions on planer foil targets
10. Data analysis and interpretation of experimental data

The deliverables produced under the subcontract included:

1. Presentation of Bremsstrahlung spectrometer at a High Temperature Plasma Diagnostics (HTPD) conference. (LLNL-CONF-403592)
2. Publication of the Bremsstrahlung spectrometer design and sample data in the peer-reviewed conference proceedings of HTPD. (REVIEW OF SCIENTIFIC INSTRUMENTS 79, 10E305 2008)
3. Publication of an internal LLNL memo compiling image plate dosimeter composition data
4. Calibrations and software for the Single Hit Spectrometer
5. Presentation of electron generation results at three national conferences in the form of posters and talks.
6. Submission for publication of the experimental results in Physics of Plasmas. (article published: PHYSICS OF PLASMAS 16, 082705 2009.)